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Paraparchites mazonensis n. sp. (Ostracoda) from Middle Pennsylvanian Ironstone Concretions of Illinois

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ABSTRACT

A new ostracode species, *Paraparchites mazonensis*, is described from Mazon Creek concretions in the Middle Pennsylvanian Francis Creek Shale of Savage, 1927 (Desmoinesian = Westphalian C) in northeastern Illinois. The occurrence of this genus suggests a brackish water environment in the areas of formation of the ostracode-bearing ironstone concretions.

INTRODUCTION

Many of the fossil animals preserved in concretions collected in the Mazon Creek area in northeastern Illinois from the Middle Pennsylvanian Francis Creek Shale of Savage, 1927 have been described (Johnson and Richardson, 1966; Richardson and Johnson, 1971; Schram and Nitecki, 1975, and references therein). This is the first description of an ostracode from Mazon Creek concretions in the Braidwood fauna, hitherto considered to represent a non-marine facies.

The Mazon Creek ironstone concretions have been collected by many amateurs from spoil heaps of many strip mines in the Middle Pennsylvanian Francis Creek Shale (Desmoinesian = Westphalian C) in Will and Grundy Counties, Illinois (Richardson and Johnson, 1971, fig. 1). Field Museum of Natural History (FMNH), Chicago, has accumulated by gift and loan an enormous number of these concretions. In June, 1972, I visited the Museum and selected ostracode-bearing concretions for study. These concretions were collected mostly by Mr. George Langford. Dr. Eugene S. Richardson, Field Museum of Natural History, escorted me through the Mazon

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Creek area, including some strip mines. Ostracode-bearing concretions were not found during that excursion, but I collected some of the enclosing shales for processing. Unfortunately, the shale collections did not contain any ostracodes.

METHODS OF STUDY AND PRESERVATION

Experimentation with various acids revealed that dilute HCl released specimens from the concretions. One half of each of 22 split concretions was treated with dilute HCl until the ostracodes fell off the inside surface (fig. 1). The acid was carefully decanted from the residue, which was washed with tap water several times, neutralized with soda ash, and then retained on a 100-mesh sieve for drying and picking. Because many of the ostracode specimens are fragile, the residue was not sieved into +20, 40-, 60- and 80-mesh fractions. The ostracodes were picked out of the unsized residue.

Richardson and Johnson (1971, p. 1,226) observed that the highly calcareous tests of ostracodes and mollusks are not preserved in the concretions, though they made accurate impressions before being dissolved. The ostracodes released from the ironstone concretions are present as incomplete replacements by pyrite, in some cases slightly oxydized, or as a white cryptocrystalline substance. This substance was determined by x-ray diffraction analysis to be kaolinite (P. J. Dunn, M. E. Mrose, pers. comm., 1975) and by a qualitative microprobe scan to consist of major amounts of silicon and aluminum, with possible trace amounts of sodium, potassium, chlorine, calcium, sulfur, and iron (R. B. Finkelman, pers. comm., 1973).

A plausible sequence of fossilization would be for pyrite to replace either the inner and outer surfaces of each valve or to form a thin coating on these surfaces, for the carbonate filling between the surfaces to be dissolved and then replaced by kaolinite which also filled the inside of the carapace. Some of the pyrite was weathered either during the solution phase or contemporaneous with the kaolinite deposition. Figure 3 indicates that some of the carbonate of the valve was replaced by pyrite because these SEM micrographs were made without heavy-metal coating. Figure 3B suggests a two-layered ultrastructure of the shell, however, it is probable that the outermost third layer is missing. The continuous smooth boundary on the inside layer of Figure 3B may represent a thin pyritic coating on top of the inside of the valve, rather than actual replacement of the inside surface of the valve.

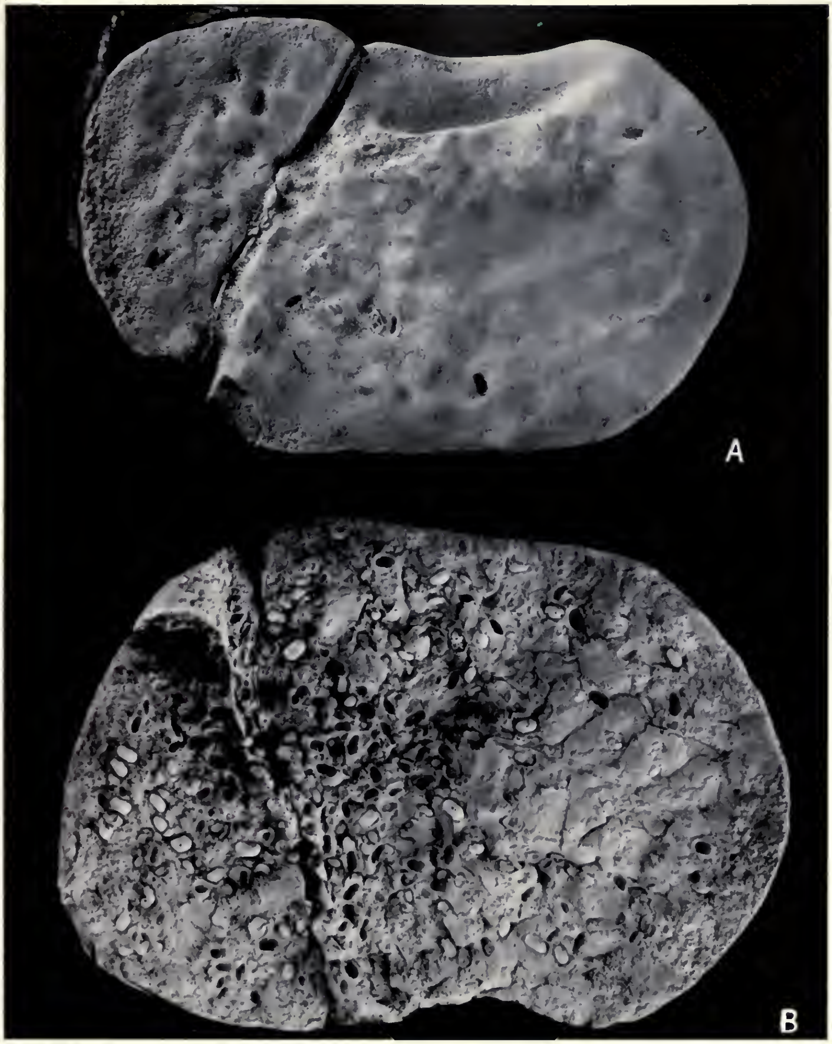

FIG. 1. Photographs, ×1½, of processed and unprocessed halves of concretion FMNH PE-945. **A**, Specimen treated with dilute HCl so that most of the specimens were released; **B**, Untreated counterpart.

The ostracodes form a layer approximately 1 cm. or less thick that is parallel to the bedding plane. They do not exhibit any preferential orientation within this layer, and are present mostly as complete carapaces, some broken, and a few as single valves (fig. 2). Figure 2 shows a thin-section across the bedding plane of a concretion; the outer and the inner surfaces of the valves that are replaced by pyrite

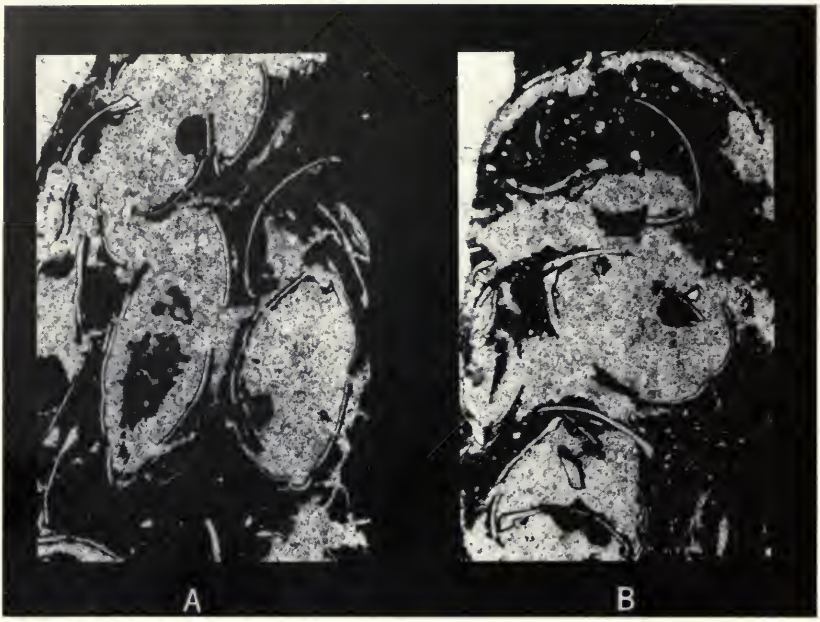

FIG. 2. Thin-section across bedding plane of concretion FMNH PE 16065; approximately ×25. The slide broke during polishing, the top of B fits below the lower left of A.

or limonite are seen as black lines; the white filling between these lines is kaolinite which also fills the inside of the carapaces. Some of the shells show breakage; in other shells the kaolinite appears to have ruptured the carapace, and in places absorbed and replaced the pyritized fossils.

Ostracodes freed from the concretion are poorly preserved, none has the exterior preserved (figs. 3-10). In an earlier study (Sohn, 1960, p. 7) I had noted that on a pair of closed ostracode valves, the hinge line and the ventral and end margins have a groove where the two valves meet. The specimens illustrated in ventral view (figs. 6A, 10E) do not show that overlap. Similarly, the specimens illustrated in dorsal view (figs. 7C, 8B, 9A, C, E, 10B, H) and in end view (figs. 5A, 6B, 7A, 9G) also do not show the overlap. The overlap, however, is shown in the thin-section (fig. 2B). The carapaces are relatively thick and are replaced (fig. 5B, C). However, the carapace illustrated in Figure 6 represents only the replaced inside layer of the shell, as indicated by the similarity of the adductor muscle attachment pattern in Figure 6C as compared with Figure 5B, C that shows the same area beneath a relatively thick shell.

Figures 3 and 4 are SEM micrographs of a pyritized half of a carapace found in the residue showing a sheared surface. This specimen and the thin-section (fig. 2) demonstrate that, unlike the concretions that contain perfectly preserved soft-bodied animals (Richardson and Johnson, 1971, figs. 3A-D), some of the ostracodes in the concretions underwent internal stress at some time after the formation of the concretions. Figure 4B shows a much better preserved adductor muscle attachment scar pattern than the specimens shown in Figures 5 and 6. The rough surface on Figure 3B is additional evidence that the outermost layer of the ostracode shell is missing, and it shows also the ultrastructure of the shell layer preserved on the specimen illustrated on Figure 5. The inner calcified layer of the shell that is replaced by kaolinite in many of the specimens (fig. 2) can be seen on Figure 4B as a distinct layer to the left of the photograph, below the layer that is shown in detail on Figure 3B.

ECOLOGIC INFERENCES

The concretions were collected from spoil heaps of strip mines over a large area during a period of many years; consequently, there is no precise stratigraphic and geographic information for individual concretions. The ostracodes are mostly complete carapaces, and represent females, males, and juveniles. This suggests that little or no transport occurred prior to the formation of the concretions. I examined 52 concretions, and found only one poorly preserved clam on the unprocessed half of PE-925, and one filling of a snail in the processed residue of the same concretion. All the other concretions contained ostracodes exclusively. The ostracodes in the concretions are not so abundant as to be considered a coquina (figs. 1, 2), usually present in freshwater sediments. The presence of only one species of ostracodes to the virtual exclusion of associated species has been interpreted to indicate an abnormal environment. This may mean either hypersaline or brackish water environments.

The ostracodes belong to the marine genus *Paraparchites* Ulrich and Bassler, 1906. I had previously (Sohn, 1971, p. A2) suggested that this genus may also occur in brackish water. Based on the presence of *Paraparchites*, the concretions in which they occur probably formed in a brackish water environment. It should be noted, however, that ostracode-bearing concretions represent a small frac-

tion of the animal-bearing concretions. Richardson and Johnson (1971, p. 1,232) reported that the Ostracoda accounted for only 6.2 per cent of the arthropods in the Braidwood fauna, consequently the brackish-water environment inferred from the ostracodes should not be used as evidence that all the Braidwood concretions were formed in that environment.

SYSTEMATIC DESCRIPTION

Order Podocopida Sars, 1866

Superfamily Paraparchitacea Scott, 1959 emended Sohn, 1971

Family Paraparchitidae Scott, 1959 emended Sohn, 1971

Genus **Paraparchites** Ulrich and Bassler, 1906 emended Scott, 1959

See Sohn (1971, p. A5) for a discussion of this genus. The species in the Mazon Creek concretions has the dimorphism attributed to *Paraparchites*, and, although not illustrated in this study, rare broken carapaces have an inner lamella.

Paraparchites mazonensis Sohn, n. sp. Figures 3-10A-I

Name.—For Mazon Creek.

Holotype.—Female, FMNH PE 28610, Figure 5A-C.

Paratypes.—FMNH PE 28611, PE 28612, PE 28635-28642.

Material.—More than 300 specimens and fragments in various stages of preservation.

Type-locality.—Undeterminable, various spoil banks from strip mines in Will and Grundy Counties, Illinois.

Type-level.—Middle Pennsylvanian Francis Creek Shale of Savage, 1927 (Desmoinesian = Westphalian D), immediately above Illinois Coal 2.

Diagnosis.—Subovate, with straight, long dorsal margin, greatest height slightly more than one-half greatest length. Right valve overlaps left along free margins. Dimorphic in width of posterior; greatest width in end view below midheight in females, above midheight in males and juveniles; greatest height of females in ventral quarter, of males and juveniles in dorsal quarter. Thick shelled. Adductor muscle attachment scar rounded aggregate of small individual scars. Reversal of overlap unknown.

Description.—Because of poor preservation, the outer surface is unknown, the shell is thick (fig. 5). The right valve apparently overreaches slightly the left along the middle of the dorsal margin, and the hinge may be slightly incised (figs. 2B, 7-10A-I). In juveniles and males, the greatest height is just behind the anterocardinal angle (figs. 7-10A-I), while in females it is just in front of the posterocardinal angle (figs. 5, 6). The anterior margin is larger and more rounded than the posterior margin in males and juveniles, whereas in females the posterior margin is larger and more rounded than the anterior margin (figs. 5, 6). This phenomenon has not yet been described in the Paraparchitidae. The greatest width in dorsal view is just behind the approximate midlength in juveniles and males (figs. 7-10A-I), and at the posterocardinal angle in females (fig. 6). In posterior view, the greatest width is below midheight in females (figs. 5, 6), and above midheight in males and juveniles (figs. 7, 9, 10A-I).

The subcircular adductor muscle attachment scar (figs. 4-7) is located at or slightly in front of the midlength. It consists of numerous individual flecks, and is similar to, but better preserved than that of *Chamishaella carbonaria* (Hall, 1858), also in the Paraparchitidae, as illustrated by Sohn (1972, pl. 5, figs. 12, 13, 16).

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Figure 5	2.1	1.2	1.0
Figure 6	2.05	1.25	1.0
Figure 7	1.9	1.1	0.85
Figure 8	1.62	0.95	0.7
Figure 9A, B	0.8	0.42	0.3
Figure 9C, D	0.92	0.56	0.45
Figure 9E-G	1.3	0.8	0.6
Figure 10A-C	0.93	0.54	0.44
Figure 10D-F	1.08	0.7	0.5
Figure 10G-I	1.39	0.81	0.61
FMNH PE 28635	0.63	0.4	0.3

Discussion.—The measurements are all short because part of the thick shell as seen in Figure 5 is missing. Some of the specimens (figs. 6c, 10d, f, i) have a rugulose surface, but, because the carapaces are definitely sub-internal casts, part of the shell is missing, and this surface should not be interpreted as the surface of the outside of the shell. Examination of untreated concretions did not disclose any definite shell surface. The largest specimen seen, greatest

length 2.4 mm., is on concretion P-29450. One unnumbered concretion has a partly exposed steinkern which had the color and cleavage of calcite, and the exposed surface reacted violently to dilute hydrochloric acid. Other steinkerns on the same concretion are composed of a white lustrous substance similar to that determined to be kaolinite. The fact that some calcite is present as fillings of some of the carapaces explains the hollow and partly hollow carapaces, such as illustrated on Figures 6 and 10 because they were released with dilute HC1.

The possibility that the specimens designated as females are not conspecific with those designated as males and juveniles is rejected for the following reasons: *Paraparchites* is known to be dimorphic, and no juveniles with the lateral outline and width of posterior similar to females are present. If smaller specimens of one taxon are present, there is no reason for smaller specimens of a closely related associated taxon not to be present. As shown on the illustrations and the measurements, the males and juveniles range in greatest length from 0.63 to 1.9 mm., and the females from 2.05 to 2.1 mm.

A few specimens, particularly those recovered from concretion no. P-29450, differ in having a straight ventral margin as illustrated on Figure 10j-l. They are all more than 1 mm. in greatest length, and have the same dimorphism in width of posterior, but not in greatest height. Because the exact geographic and stratigraphic relation between the concretions is unknown, and because juveniles of this variant smaller than 1 mm. are not available, I am not describing this taxon, and am referring to it as *Paraparchites* aff. *P. mazonensis*.

The lateral outline and dimorphism in greatest height distinguish this species from all other species in the genus.

Paraparchites aff. P. mazonensis Sohn. Figure 10J-L.

Large specimens, 1 mm. or more in greatest length, and dimorphic in width of posterior are associated with *P. mazonensis*. These specimens differ in lateral outline by having a straight ventral margin.

Measurements (in mm.).—

Figure 10J-L	Greatest length	Greatest height	Greatest width
PE28643	1.64	0.96	0.75

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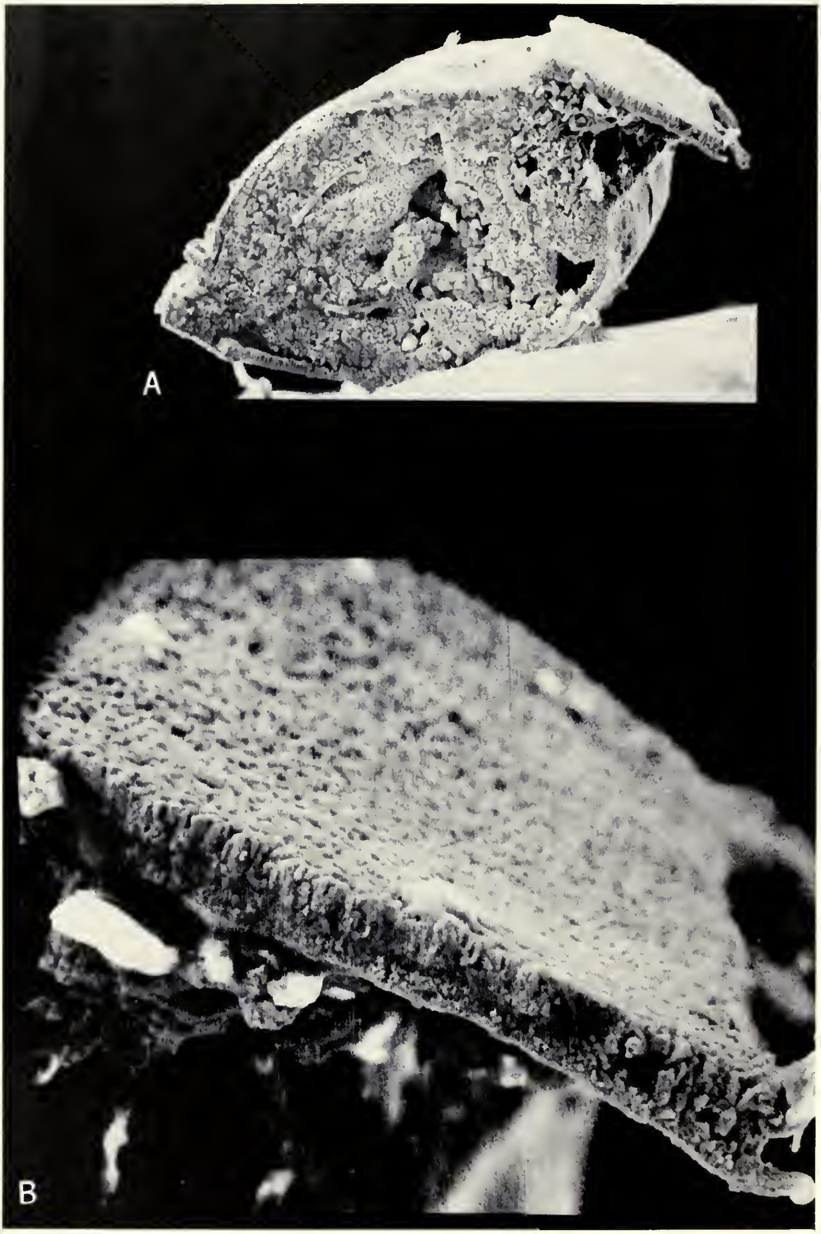

FIG. 3. *Paraparchites mazonensis* Sohn, n. sp. **A**, Oblique view of half of a carapace; approximately ×75. **B**, Detail of ventral portion of left valve; approximately ×390. Paratype, FMNH PE 28611. Concretion no. P-30412.

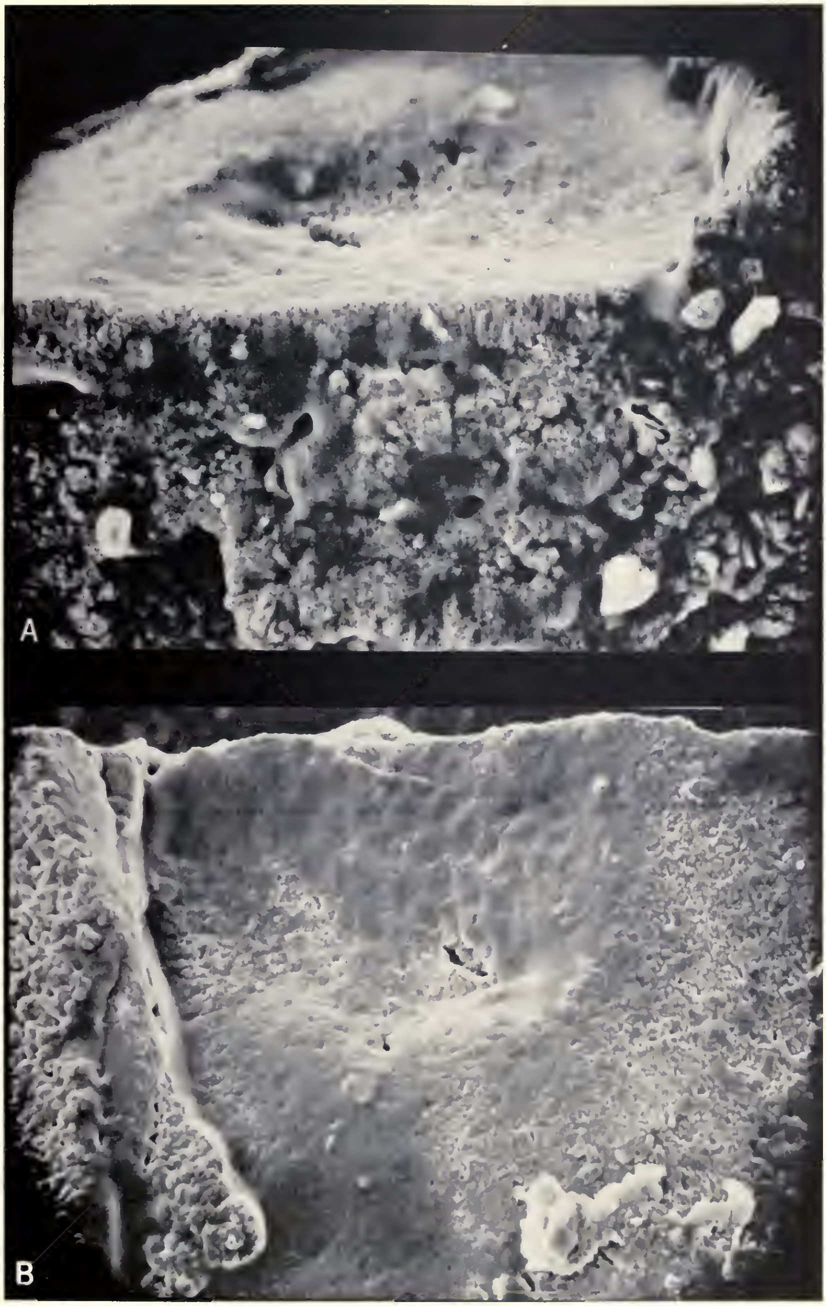

FIG. 4. *Paraparchites mazonensis* Sohn, n. sp. A, Oblique view of central portion showing adductor attachment muscle scar pattern; approximately ×390. B, Lateral view of the same area; approximately ×300. Paratype, same specimen as Figure 3.

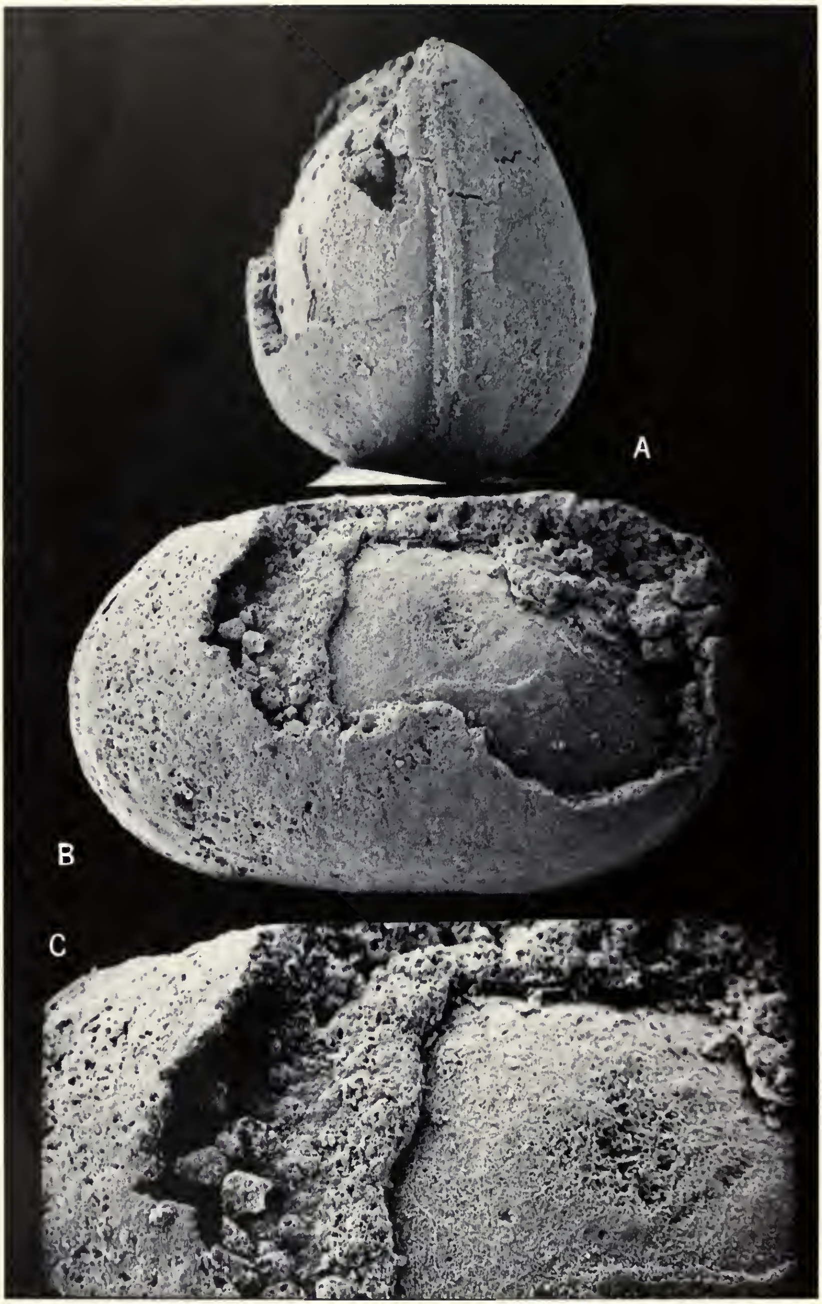

FIG. 5. *Paraparchites mazonensis* Sohn, n. sp. Posterior, left, and detail of left valve of female. **A, B** approximately ×50; **C**, approximately ×100. Holotype, FMNH PE 28610. Concretion no. PE-937.

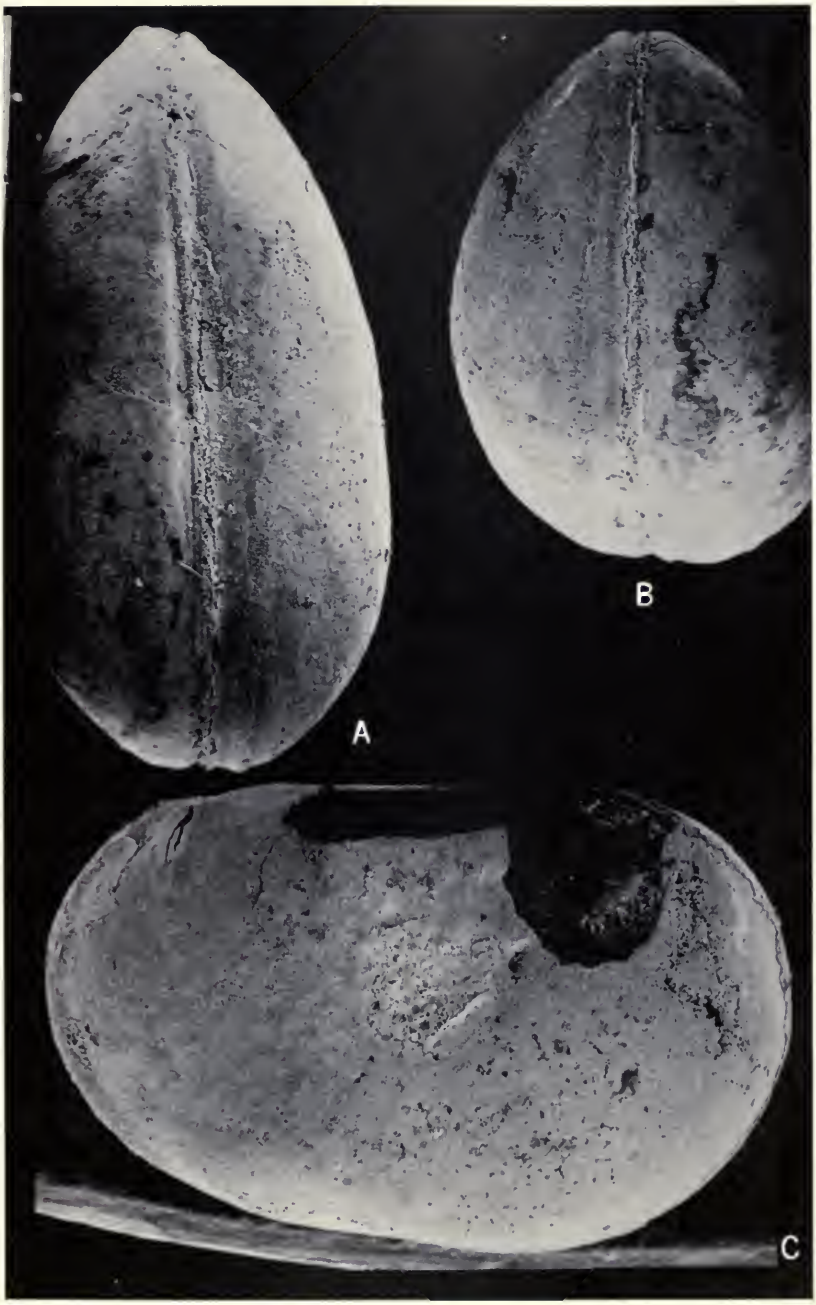

FIG. 6. *Paraparchites mazonensis* Sohn, n. sp. Ventral, posterior, and left views of female; approximately ×50. Paratype, FMNH PE 28612. Concretion no. PE-16069.

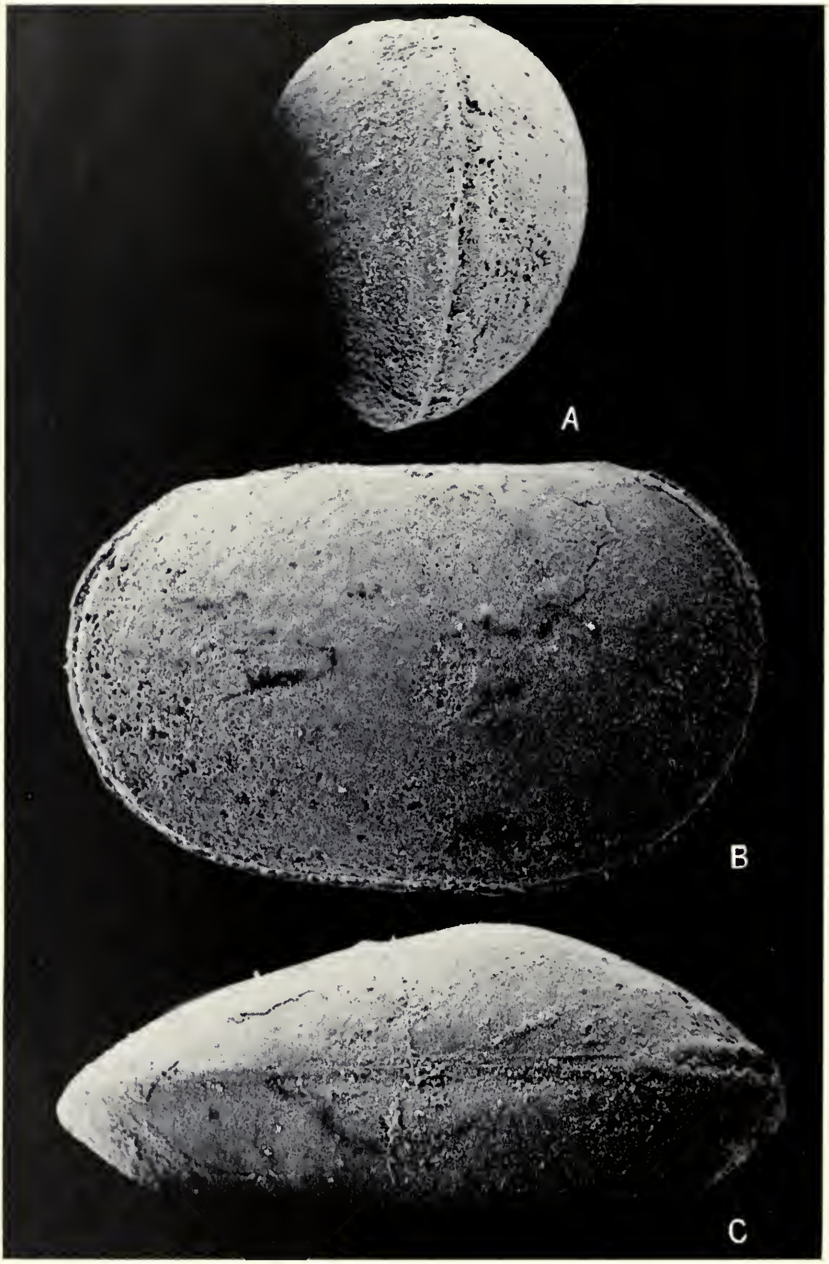

FIG. 7. *Paraparchites mazonensis* Sohn, n. sp. Posterior, right, and dorsal views of male; approximately ×50. Allotype, FMNH PE 28635. Concretion no. PE-937.

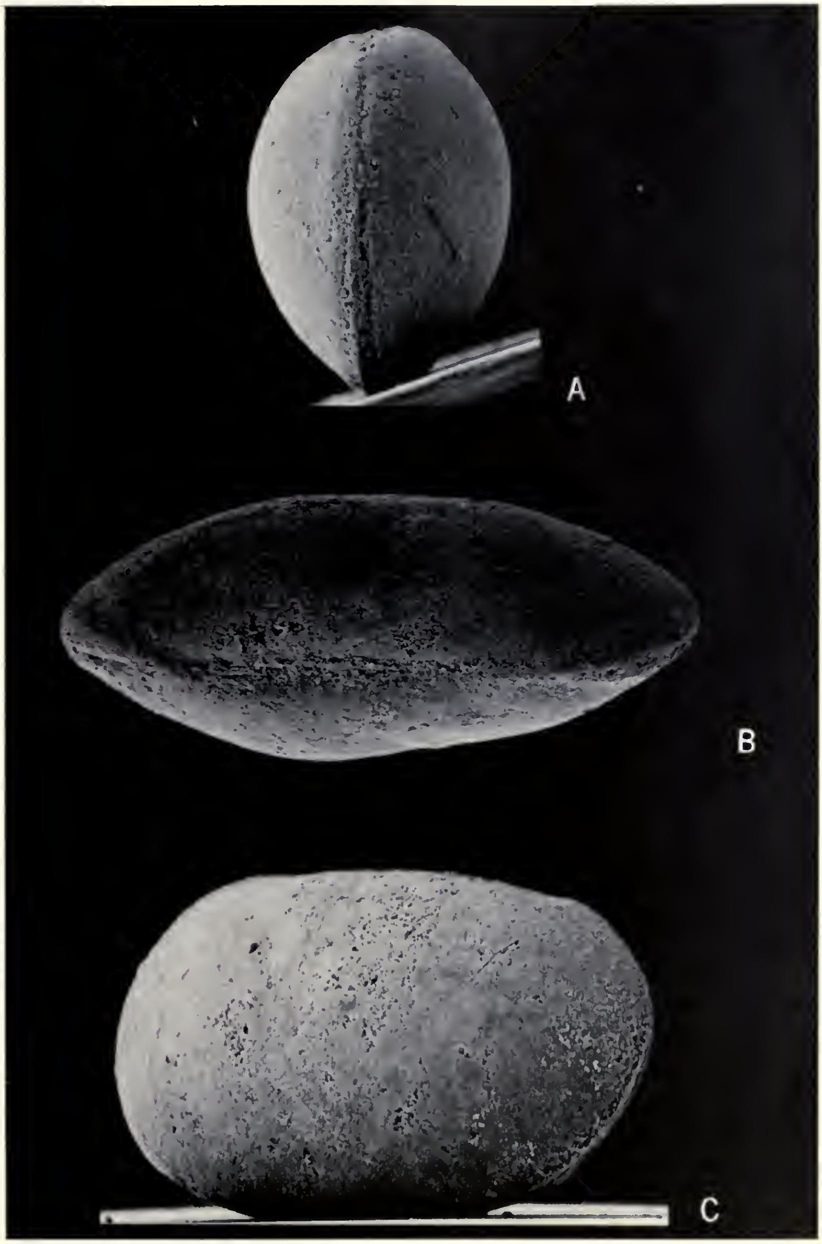

FIG. 8. *Paraparchites mazonensis* Sohn, n. sp. Posterior, dorsal, and left views of growth stage; approximately ×50. Paratype, FMNH PE 28636. Concretion no. PE-937.

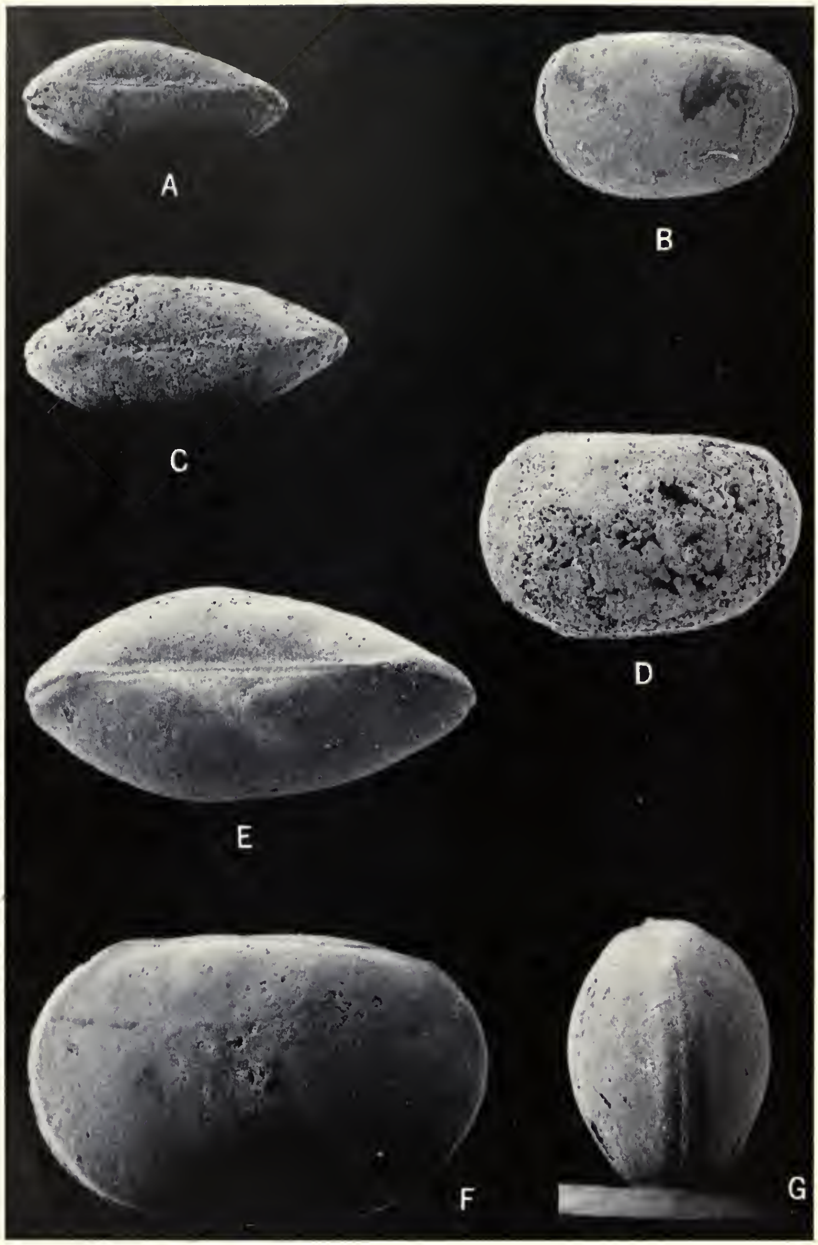

FIG. 9. *Paraparchites mazonensis* Sohn, n. sp. Three growth stages; approximately ×50. **A**, **B**, Dorsal and left view of carapace. Paratype, Field Museum no. PE 28637; **C**, **D**, Dorsal and left views of carapace. Paratype, FMNH PE 28638; **E-G**, Dorsal, left, and posterior views of carapace. Paratype, FMNH PE 28639. All from concretion no. PE-937.

FIG. 10A-I. *Paraparchites mazonensis* Sohn, n. sp. Growth series; approximately ×30. **A-C**, Left, dorsal, and right views of instar. Paratype, FMNH PE 28640; **D-F**, Right, ventral, and left views of larger instar. Paratype, FMNH PE 28641; **G-I**, Left dorsal and right views of larger instar. Paratype, FMNH PE 28642. Concretion no. PE 16064. **J-L**, *Paraparchites* aff. *P. mazonensis* Sohn. Left, dorsal, and right views of instar. FMNH PE 28643. Concretion no. PE 16064.